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Description of *Streptococcus pneumoniae* infections in burn patients☆

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ABSTRACT

Background: Longer survival in burn patients has resulted in more infectious complications, typically with *Klebsiella pneumoniae*, *Pseudomonas aeruginosa*, *Acinetobacter baumannii*, and *Staphylococcus aureus*. Although *Streptococcus pneumoniae* infections are common in the community and can cause nosocomial infections, the incidence and risk factors for pneumococcal infections in burn patients is unclear.

Methods: We performed an electronic retrospective chart review to collect rates of and risk factors for *S. pneumoniae* infections in patients with thermal burns from March 2003 through June 2008.

Results: Of the 1838 patients admitted to the burn center, 10 were infected (0.54% incidence). Patients presented with pneumonia (seven patients, 0.38% incidence) and bacteremia (three patients, 0.16% incidence) within a week of initial burn (median 1 day, range 0–8), often in the setting of bacterial co-infection (five patients). This group was mainly young males with median 28.8% total body surface area burns; 60% had concomitant inhalational injury. Most did not have traditional risk factors for pneumococcal infection but had objective signs of infection at time of positive culture and were treated with appropriate antibiotics. Two patients in this series died, although no mortality was attributed to *S. pneumoniae*.

Conclusions: Pneumococcal disease is not common in burn patients and generally occurs early on in hospitalization after burn making it more likely to be a community-acquired pathogen rather than nosocomial in the burn population. It should be considered in the setting of sepsis or new pulmonary infiltrates within a week after burn, but typical empiric antibiotics against the usual burn pathogens should be adequate to also treat for pneumococcal infection.

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1. Introduction

Improvements in burn care have led to extended survival in patients with severe burns, thus allowing more time for infectious complications to occur [1]. Infections are a significant cause of death in burn patients, with a recent study of attributable mortality by autopsy finding 61% due to infectious causes [2]. Pneumonia and bloodstream infections are common among burn patients, as are burn wound infections [1,3]. Bacteria implicated in these respiratory, endovascular, and burn wound infections infections include gram negative bacteria such as *Klebsiella pneumoniae*, *Pseudomonas aeruginosa*, and *Acinetobacter baumannii–Acinetobacter calcoaceticus* complex (ABC), and the gram positive bacteria *Staphylococcus aureus*. *K. pneumoniae* and *P. aeruginosa* in particular are responsible for increased mortality [2,4,5].

Clinically significant infections due to *Streptococcus pneumoniae* are frequent in patients admitted to the hospital without burns. *S. pneumoniae* remains the most common cause of community-acquired pneumonia and meningitis [6,7]. Incidence of these infections is increased in patients with altered respiratory clearance mechanisms such as in cigarette smokers and chronic lung disease patients. It is unclear what role smoke inhalation plays in respiratory clearance, though it is known that there is an increased risk of subsequent pneumonia following inhalational injury [8,9]. A retrospective cohort study evaluating the incidence of pneumonia in patients with greater than 20% total body surface area (TBSA) burns found that pneumonia in burn patients is mainly an endogenous problem, typically from the patient's oropharyngeal or gastrointestinal flora, often via aspiration. In that study, 6 out of the 21 cases of endogenous pneumonia, which were diagnosed at a median of 3 days post-burn (range 1–4 days), were caused by *S. pneumoniae* and the rest by other community-acquired bacteria (*Staphylococcus aureus* and *Haemophilus influenzae*) [10].

To our knowledge there are no published data specifically detailing the incidence of or risk factors for pneumococcal infections in burn patients. The purpose of this study was to describe pneumococcal infections in this population.

2. Methods

After institutional review board approval was obtained, we performed an electronic retrospective chart review in the US Army Institute of Surgical Research (USAISR) Burn Center. The USAISR Burn Center is a 40-bed unit located within Brooke Army Medical Center that serves Department of Defense beneficiaries worldwide and the civilian population from within the southern Texas regional trauma system. Standard burn patient care in our center has been described previously and includes early burn wound excision and skin grafting, bronchoscopy within 24 h of admission if there is suspicion of inhalational injury, and aggressive infection control [4].

For the period including 1 March 2003 through 30 June 2008, electronic clinical microbiologic culture database results from any site, including blood, sputum, bronchoalveolar lavage fluid, urine, cerebrospinal fluid (CSF), and skin were screened for the recovery of *S. pneumoniae*. Once patients with positive cultures were identified, we utilized our electronic medical records system to characterize patient demographics and potential risk factors for *S. pneumoniae* infection. The patients' electronic charts were reviewed for comorbidities and clinical indicators of infection. A co-infection was defined as a positive culture from the sites listed above for an organism other than *S. pneumoniae* from within 24 h prior and 24 h after the positive culture for *S. pneumoniae* was obtained. Appropriate antibiotics were defined as antibiotics that the specific isolate was susceptible to based on our microbiologic data. The definition of fever was taken from the American Burn Association Consensus Conference to Define Sepsis and Infections in Burn Patients, with fever defined as a temperature greater than 39 °C and hypothermia defined as temperature less than 36.5 °C [11]. Descriptive statistics were performed using SPSS 16.0 (SPSS Inc., Chicago, Illinois). The incidence values for *S. pneumoniae* infections in our facility were calculated using information from a clinical registry maintained by the burn center containing information about all admissions. Patients admitted with non-thermal injuries (i.e. toxic epidermal necrolysis or other exfoliating skin conditions) were excluded from our calculations and our case series.

3. Results

During the study period, 1838 patients were admitted to the USAISR Burn Center with burns, with a median TBSA burn of 9.5% (range 0.1–99%), a median age of 29 (range 8–101), and a median injury severity score (ISS) of 5 (range 1–75). Most of the patients were men (85.6%) and 11.6% of them had associated inhalational injury. The median percent of full thickness burns was 7% (range 0–97.5%). More than one-third of patients (37.6%) had been burned during military operations in Iraq and Afghanistan.

Among these patients, there were 10 patients with 15 clinical cultures positive for *S. pneumoniae* (Table 1) resulting in an overall incidence of 0.54% of clinical cultures positive in this population among all admissions. Of these patients, nine were men. The median TBSA burn was 28.8% (range 7–66%), median full thickness burn was 3% (range 0–53%), median age was 38.5 (range 20–91), and the median ISS was 18 (range 1–51). Two of these patients were burned during military operations. Inhalational injury was diagnosed in six on admission. Seven patients had *S. pneumoniae* pneumonia (0.38% incidence) and three patients had bacteremia (0.16% incidence).

Only one of these patients had been hospitalized recently prior to this admission, aside from transient stays in emergency facilities for their burns en route to our hospital. None of them had been documented to be on antibiotics in the recent past before this admission. Three patients had a history of active tobacco use at time of admission. Of note, none of these patients had a documented history of splenectomy or known history of receipt of the pneumococcal polysaccharide vaccine.

Most patients with *S. pneumoniae* isolated from clinical culture were treated with appropriate antibiotics. The isolates were susceptible to most antimicrobials with 12 isolates susceptible to penicillin and 14 susceptible to ceftriaxone. Two patients died; both of these had been on appropriate

Table 1 – Characteristics of burn patients with cultures positive for *Streptococcus pneumoniae*, 2003–2008.

Case	Age/ gender	% TBSA (%FT)	Inhalational injury	ISS	Time to pos Cx (days)[a]	Site of culture	Pneumonia on CXR	Fever (>39 °C)	Comorbid conditions	History of vaccination[b]	WBC on day of Cx in cells/μl (%PMNs)	Co-infections	Treated for *S. pneumoniae*	Mortality (attributable)	Days until death or discharge
1	38/M	45 (20)	No	26	0	Tracheal asp	Yes	Yes	None	No	7.1 (72)	MSSA, *Serratia*, *Enterobacter* pneumonia	Yes	No	61
2	51/M	26.5 (19.5)	Yes	10	0, 2	Tracheal asp	No, yes	Hypothermia, no	Hepatitis C	Unknown	8.6 (84), 14.6 (86)	*Haemophilus influenzae* pneumonia	No	No	40
3	48/M	21.5 (1)	No	9	1	Sputum	Yes	Yes	Alcoholic	Unknown	5.6 (77)	No	Yes	No	36
4	26/M	54.5 (0)	No	1	1	Tracheal asp	Yes	Yes	Marijuana, cocaine abuse	Unknown	16.6 (86)	No	No	No	41
5	39/M	6.5 (0)	Yes	10	2	BAL	Yes	Yes	None	Unknown	5.5 (75)	No	Yes	No	8
6	23/M	8 (5)	Yes	18	0, 2	Blood	Yes	Yes, yes	None	No	3.4 (88), 2.5 (81)	No	Yes	No	38
7	20/M	66 (53)	Yes	51	1	Blood	Yes	Hypothermia	Unknown	Unknown	2.3 (71)	MSSA bacteremia; MSSA, *Acinetobacter*, and *Enterobacter* pneumonia	Yes	Yes (no)	4
8	20/M	31 (26.5)	Yes	35	1	Blood	No	No	Unknown	No	5.4 (76)	MRSA bacteremia, MSSA pneumonia, coagulase negative staphylococci from wound	Yes	No	23
9	91/M	15 (0)	Yes	18	1	Sputum	No	Yes	COPD, CAD	Unknown	28.9 (90)	No	Yes	Yes (no)	9
10	49/F	33 (0)	No	25	6, 8	Sputum	Yes, yes	No, yes	None	Unknown	5.3 (71), 4.4 (78)	MSSA and *Serratia* bacteremia; MSSA pneumonia; *Escherichia coli* and *Serratia* UTI	Yes	No	24

TBSA: total body surface area burn; FT: full thickness burn; ISS: injury severity score; Cx: culture; CXR: chest X-ray; WBC: white blood cell; PMNs: polymorphonuclear cells; COPD: chronic obstructive pulmonary disease; CAD: coronary artery disease; MSSA: methicillin-susceptible *Staphylococcus aureus*; MRSA: methicillin-resistant *Staphylococcus aureus*; tracheal asp: tracheal aspirate; BAL: bronchoalveolar lavage.

[a] Days from admission.

[b] Vaccination with 23-valent pneumococcal vaccine.

antibiotics to treat the *S. pneumoniae* and died within 2 weeks of admission. Only one of the patients who died had an autopsy report available for review. It did not specifically attribute any mortality to *S. pneumoniae*. Neither patient had infection due to *S. pneumoniae* cited as a cause of death. The causes of death listed for one of the patients were severe steam inhalational injury, necrotizing acute respiratory distress syndrome, scald burn, rhabdomyolysis, and acute renal failure. This patient also had methicillin-sensitive *Staphylococcus aureus* bacteremia and ABC and *Enterobacter* species grow on respiratory cultures. None of these bacteria were specifically attributed as a cause of his death in the autopsy report. The other patient's cause of death was documented as cardiovascular collapse, ischemic colitis, and burn. He had no co-infections or infectious cause of death documented. Among all of the patients, the median number of days from positive culture to discharge or death was 36 (range 4–61). Over the study time period, 7.5% of all the 1838 patients admitted to the burn center died of various causes and 92.1% were alive as of the time of data collection.

4. Discussion

Infections are a common cause of morbidity and mortality in burn patients. In our retrospective review, we found that the rate of isolation of *S. pneumoniae* from clinical cultures is low, with only 10 patients having clinical cultures positive for this organism out of the 1838 patients admitted to the burn center during the 5-year time frame studied (0.54% incidence). The presence of *S. pneumoniae* appeared to correlate with clinically significant infectious processes since most patients were either febrile or hypothermic at time of culture and had findings consistent with pneumonia on chest radiography. However, it did not seem to be the cause of death in the two patients who died.

Infections due to *S. pneumoniae* generally occurred soon after admission, which lends credence to *S. pneumoniae* generally being a community-acquired organism in the burn population. This is similar to findings in the medical literature in which 90% of cases of pneumococcal bloodstream infections are acquired in the community. However the 10% of cases of *S. pneumoniae* infections that are nosocomially acquired have been found to contribute to excess mortality as compared to community-acquired pneumococcal bacteremia [12]. Though the literature defines nosocomial pneumococcal bloodstream infections as those occurring at greater than 72 h after admission, results from studies indicate that generally, these infections occur after a more prolonged hospitalization, with one group finding that the mean date of nosocomial pneumococcal bacteremia was more than 22 days after admission, which clearly exceeds our latest day of positive culture (day 8 of hospitalization) [13].

Our low rate of nosocomial pneumococcal infection may be, in part, related to the aggressive infection control practices enforced in the burn unit and the community-acquired nature of these illnesses may, in part, explain the low mortality in our series, as the overall case-fatality rates have been shown to be significantly higher (up to twice as high) in cases of nosocomial pneumococcal infection as compared to community-acquired [12,14]. In contrast to the general population where pneumococcal disease is associated with a substantial case-fatality rate of 9.8%, there was no mortality attributed to pneumococcal disease among the patients we studied [6]. This may be due to the overall younger age and lack of comorbid conditions of our patient population [6,12]. Based on our findings, there does not appear to be a significant need for empiric coverage for *S. pneumoniae* when covering for other nosocomial infections in patients with prolonged burn unit stays. However, it is important to note that our burn patients receive perioperative vancomycin routinely as well as imipenem for empiric broad spectrum antibiotic therapy for sepsis, thus this particular population will likely receive adequate antibiotic therapy to treat *S. pneumoniae* in the course of their typical empiric coverage for other common burn pathogens.

Infections with *S. pneumoniae* are uncommon in burn patients, occur very early after admission, and are not associated with increased mortality. Consequently, new onset infections occurring in this population after a prolonged hospitalization should be treated with standard antimicrobials active against typical burn pathogens.

Conflicts of interest

We have no conflicts of interest or disclosures.

REFERENCES

[1] Church D, Elsayed S, Reid O, Winston B, Lindsay R. Burn wound infections. Clin Microbiol Rev 2006;19:403–34.
[2] Gomez R, Murray CK, Hospenthal DR, Cancio LC, Renz EM, Holcomb JB, et al. Causes of mortality by autopsy findings of combat casualties and civilian patients admitted to a burn unit. J Am Coll Surg 2009;208:348–54.
[3] Mayhall CG. The epidemiology of burn wound infections: then and now. Clin Infect Dis 2003;37:543–50.
[4] Regules JA, Glasser JS, Wolf SE, Hospenthal DR, Murray CK. Endocarditis in burn patients: clinical and diagnostic considerations. Burns 2008;34:610–6.
[5] Regules JA, Carlson MD, Wolf SE, Murray CK. Analysis of anaerobic blood cultures in burned patients. Burns 2007;33:561–4.
[6] Robinson KA, Baughman W, Rothrock G, Barrett NL, Pass M, Lexau C, et al. Epidemiology of invasive *Streptococcus pneumoniae* infections in the United States, 1995–1998, Opportunities for prevention in the conjugate vaccine era. J Am Med Assoc 2001;285: 1729–35.
[7] Schuchat A, Robinson K, Wenger JD, Harrison LH, Farley M, Reingold AL, et al. Bacterial meningitis in the United States in 1995. N Engl J Med 1997;337:970–6.
[8] Musher DM. Infections caused by *Streptococcus pneumonia*: clinical spectrum, pathogenesis, immunity, and treatment. Clin Infect Dis 1992;14:801–9.
[9] Shirani KZ, Pruitt BA, Mason AD. The influence of inhalation injury and pneumonia on burn mortality. Ann Surg 1987;205:82–7.
[10] de la Cal MA, Cerda E, Garcia-Hierro P, Lorente L, Sanchez-Concheiro M, Diaz C, et al. Pneumonia in patients with severe burns: a classification according to the concept of the carrier state. Chest 2001;199:1160–5.

[11] Greenhalgh DG, Saffle JR, Holmes JH, Gamelli RL, Palmieri TL, Horton JW, et al. American burn association consensus conference to define sepsis and infection in burns. J Burn Care Res 2007;28:776–90.
[12] Lyytikainen O, Klemets P, Ruutu P, Kaijalainen T, Rantala M, Ollgren J, et al. Defining the population-based burden of nosocomial pneumococcal bacteremia. Arch Intern Med 2007;167:1635–40.
[13] Bouza E, Pintado V, Rivera S, Blazquez R, Munoz P, Cercenado E, et al. Nosocomial bloodstream infections caused by *Streptococcus pneumoniae*. Clin Microbiol Infect 2005;11:919–24.
[14] Rubins JB, Cheung S, Carson P, Rubins HB, Janoff EN. Identification of clinical risk factors for nosocomial pneumococcal bacteremia. Clin Infect Dis 1999;29: 178–83.